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AUTOMATIC INSECTICIDE-DISPENSING EQUIPMENT FOR INSTALLATION IN AIRCRAFT

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Aircraft flown over long distances creates a hazard of insect dissemination that is causing great concern. Adult insects are commonly found in airplane interiors when the planes are ready for the take-off to distant points, and if not destroyed or removed they will be transported to new areas within a matter of hours. Several instances of insects becoming well established in locations far removed from their previous known habitat have been reported recently.

It is impractical to keep insects out of grounded airplanes. Attention has long been focused on means of destroying the insects and so preventing the transport of live forms. A combination of an aerosol (space spray) and a residual spray appears to be the most satisfactory insecticidal treatment. Two procedures are now in common use for applying aerosols -- namely, treating before take-off and by crew members during flight.

Aerosols dispensed from hand containers have been used extensively on both commercial and military airplanes. When aerosols are so dispensed by different persons under various conditions, the dosage varies and the distribution is erratic. To overcome these disadvantages, automatic dispensing equipment that will apply a measured dosage and assure uniform distribution has been proposed. An automatic device for releasing liquefied-gas aerosols has been developed, which has passed initial experimental trials. Recently, arrangements were made through the Department of the Air Force to install this apparatus in Military Air Transport Service planes at Beltsville and in Hawaii, to provide operational tests.

Workers in England (Mackie and Crabtree 1) developed and tested an apparatus designed for this use as early as 1938. The Pan American Sanitary Bureau (Snow 2) in cooperation with the U. S. Navy, the Public Health Service, and the Bureau of Entomology and Plant Quarantine began work on apparatus several years ago, and later installed it in a Navy aircraft.1/ This device was used because of its simplicity, light weight, and efficiency in producing the desired range of particle sizes.

1/ Hirst, John M. Preliminary report on development of apparatus for aircraft disinsection. (Unpublished) U. S. Naval Air Station, Patuxent, Md.

Description of Apparatus

Supply Tank.--A standard portable aircraft oxygen cylinder of 104 cubic inches capacity serves as the aerosol supply tank. This cylinder is of convenient size, and is easily refilled. It is obtainable in stainless or high-carbon steel, is nonshatterable, and will withstand internal pressures well above 400 pounds per square inch. The tank is equipped with an eduction tube.

Solenoid Valves.--Standard light-weight, 24-volt, d.c. aircraft solenoid valves equipped with aromatic Neoprene on the face of the plungers are used at each point of release. The valves are connected to the manifold on the inlet side and to the nozzles on the outlet side. All the solenoids are wired to a central timing switch so that all are actuated simultaneously. A 100-mesh filter screen is placed on the inlet side of each valve to prevent improper seating or clogging of the nozzle due to foreign matter. The valves have a power consumption of about 6 watts, and withstand pressures above 200 pounds per square inch.

Nozzles.--Capillaries are used as nozzles. Typical nozzles have capillaries between 0.09 and 2.0 inches in length with the diameter of the bore ranging between 0.010 and 0.020 inch. Owing to drilling difficulties capillaries longer than 0.1 inch are made of preformed capillary tubing brazed or soldered to a threaded base. The capillary length can be extended with a threaded pin pushed into the smooth throat of the nozzle, the grooves in the threads being used for the capillary.

The space between the base of the capillary and the valve seat is kept to a minimum to prevent dripping when the valve is shut off. A screen with mesh slightly smaller than the nozzle orifice, and with at least 30 openings through which the solution can flow, is fitted in the base of the nozzle. Multiple nozzles are made with two or more capillaries to allow release in several directions.

The particle size of the aerosol produced has been found to be a function of the length of the capillary, the size of the orifice, the viscosity of the liquid, the percentage of nonvolatile material, and the pressure. It was therefore necessary to modify the nozzles to give a satisfactory discharge rate and particle-size distribution for every formula.

Manifold, or Tubing, System.--Soft aluminum tubing, 3/16 inch o.d., has been used in one aircraft installation. It is light in weight, resistant to chemical reaction with any of the ingredients used, withstands the pressure of the liquefied gas in the system, and maintains tight connections at the unions. Check valves and closed valves are not included in the system except at the supply cylinder. The valves at the supply cylinder are opened as soon as it is attached; otherwise the hydraulic pressure created by high temperature would create abnormal pressure in the manifold.

The tubing is cleaned of all dust and dirt before being installed. It is fastened in place by Adel clamps and is protected by grommets where it passes through bulkheads. Soft copper tubing 3/16 inch o.d. was used in one installation for test purposes. Stainless steel tubing is now being

tested for possible use in the manifold system.

All fittings are of the flared-tube type, of Dural metal equipped with sleeves. The system was checked for leaks after each installation. Back-seating, light-weight, hand-operated valves are used on the supply tank and on the connecting end of the manifold system. This type of valve prevents leakage around the valve stems when the system is in use. A hand-operated coupling unit is used between the supply-tank valve and the manifold valve to permit rapid changing of the supply tank. This coupling unit is fitted with an arematic Neoprene washer, which will resist the effect of the aerosol solution. All pipe threads in the installation connections are 1/8 inch. The pipe-thread connections are sealed with thread-seating compound applied after the threads are started (to prevent the compound from entering the manifold tubing).

Timing Switch.--The dosage is measured by time. The output of a set of nozzles is determined for a given solution under a given pressure. The total dosage necessary for an airplane of given capacity divided by the combined output per second determines the length of time the valves shall remain open. A mechanical timing switch commonly used in photographic laboratories is used to measure this time interval. The operator turns the indicator of this switch to a predetermined setting before releasing the aerosol. The solenoid valves open when the switch is released and remain open until the switch indicator returns to zero. With this indicator the time interval can be changed if it is necessary to change the dosage. The current is connected to the electrical system of the aircraft. The manifold system is protected with a 5-ampere circuit-breaker switch for safety. A single-wire system is used, each solenoid being grounded to the airplane frame.

Typical Installation

The manner in which the automatic insecticide-dispensing equipment is installed varies with the airplane. A typical installation, the equipment placed on a Military Air Transport Service plane at Honolulu in January 1949, will be described below.

The supply tank was located near the center of the passenger compartment about 20 feet from the front bulkhead, and fastened on the blanket rack on the right side. A wide aluminum band attached to the blanket rack held the tank in place. A back-seating valve was placed on the connecting end of the manifold system to prevent the line from draining when the supply tank was changed. A quick coupler connected this valve with the valve on the supply tank. The aluminum tubing of the manifold system was attached to the fuselage along the top of the blanket rack. The tubing to the two other solenoids beyond the blanket rack was hell tight against the fuselage with Adel clamps placed at frequent intervals.

The four points of release were as follows: (a) In the toilet above the wash-basin mirror, a single-angled outlet nozzle pointing toward the rear; (b) in the passenger compartment on the front of the blanket rack, 13 feet 4 inches from the front bulkhead, a double-angled outlet nozzle pointing front and rear (fig. 1); (c) same as preceding, but located 26 feet 8 inches from the front bulkhead; and (d) in the rear of crew's compartment

on the door frame with a single-outlet nozzle pointing forward into center of aisle (fig. 2).

The 24-volt power was taken from the circuit box located in the food compartment at the rear of the fuselage, connected by a single wire in series to a 5-ampere circuit-breaker switch, then to the timing switch located over the food compartment entrance (fig. 3). From the timing switch the single-wire circuit was connected to the four solenoids. Each solenoid was grounded to the frame to complete the circuit.

The nozzles were designed specifically for use with formulas containing Genetron-100 (ethylideno fluoride) and Freon-12 (difluorodichloromethane) as the propellent gas and had capillaries 0.09 inch long with orifice diameter of 0.017 inch (fig. 4). With formula G-575 (pyrethrum extract 5, piperonyl butoxide 2, DDT 3, cyclohexanone 5, and lubricating oil (No. 10) 1 percent in a 1:3 mixture of Genetron-100 and Freon-12) the output of each outlet was 1.6 grams per second at 90 pounds per square inch. The particles had a median mass diameter between 15 and 18 microns and a maximum diameter of 40 to 50 microns.

The weight of the equipment was 4 pounds for the filled supply tank and 4.65 pounds (2115 grams) for the rest of the system, apportioned as follows:

	Grams		Grams
Aluminum tubing	380	Backseating valve and coupler	250 2/
Solenoids	680	Quick coupler	70 2/
Timer	250 2/	Fittings	120
Wire	300 2/	Nozzles	65 2/

The equipment was as follows:

1. Supply tank. MSA breathing oxygen cylinder, Type A4-Spec. 94-40376.

2. Two mechanical valves. Back-seating type, 1/4-inch male pipe to 1/4-inch flared tube. (Calumet Angle Valve 21540 or equal.)

3. Quick coupler. 1/4-inch female flared tube to 1/4-inch female flared tube. (Superior or equal.)

4. Aluminum tubing 3/16 inch o.d., six 12-foot lengths.

5. Fittings, flared tube, all fitted with nuts (Parker AN 818-3 Dural) and sleeves (Parker AN 819-3 Dural):

    (a) 90° angle 1/8-inch pipe to 3/16-inch flared tube (Parker AN 822-3 Dural) for rear solenoid.

2/ These weights can be reduced in future installations by use of certain alloys.

(b) Connections, 3/16-inch to 3/16-inch flared tube (Parker 3 HT Dural), two required to connect 12-foot lengths of tubing in food compartment and in forward end of passenger compartments.

(c) Tees, 3/16-inch to 3/16-inch to 3/16-inch flared tube (Parker AN 824-3 Dural), three required for outlets to supply tank and solenoids in passenger compartment.

(d) Connections, 3/16-inch flared tube to 1/8-inch pipe (Parker AN 816-3 Dural), four required, three forward solenoids and one at mechanical valve.

(e) Brass coupling 1/4-inch pipe to 1/4-inch pipe with brass reducer 1/4-inch to 1/8-inch pipe. To be soldered to back-seating valve on end of manifold line.

6. Timing switch (Mark Time model 4904-4LP or equal).

7. Wire, 7-strand No. 20 low-tension aircraft type with spaghetti coverings, 65 feet.

8. Adel clamps, sheet-metal screws.

9. Solenoid valves with aromatic Neoprene plungers (Adel No. 12257-28, 24 volt or equal), four needed.

10. Four nozzles (outlets depending on type of aircraft).

11. Filler plug in outlet side of solenoid valves. (Fig. 4.)

12. Screens cut circular to 0.350 inch diameter with holes 0.01 inch in diameter (Jelliff's Lectromesh 40-mesh screen or equal). Insert 3/8-inch disk into each outlet side of solenoid valves.

13. Aluminum brackets for solenoid valves.

Literature Cited

(1) Mackie, F. P., and Crabtree, H. S.
1938. The destruction of mosquitoes in aircraft. Lancet, Aug. 20, p. 447.

(2) Snow, Donald L.
1945. A preliminary report of the development of equipment for the automatic disinsection of airplanes. Pan American Sanitary Bureau, Aug. 15. [Processed]

Figure 1.--Automatic insecticide-dispensing equipment in operation in a C-54 airplane passenger compartment.

Figure 2.--Installation of solenoid valve and nozzle in the crew's compartment of a C-54 airplane.

Figure 3.—Installation of the timing switch for the automatic insecticide-dispensing equipment in a C-54 airplane.

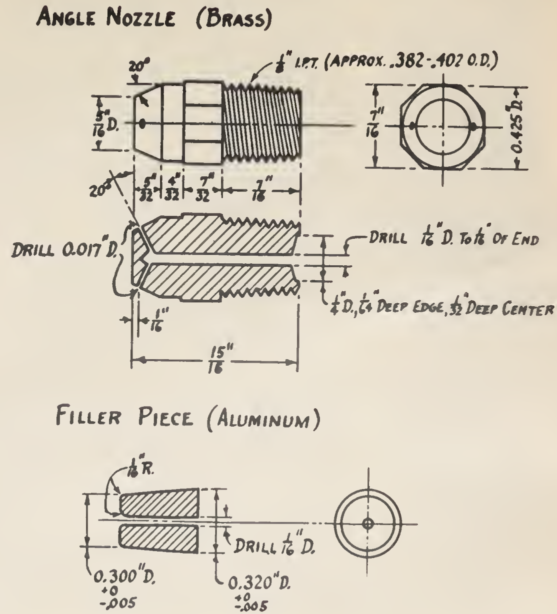

Figure 4.—Design of a nozzle and filler plug used in the automatic insecticide-dispensing equipment.